Report on Environmental Conditions in the Chesapeake Bay and Its Tributaries

2003 Annual Report from the Secretary of Natural Resources on Virginia's Chesapeake Bay Program:

Section on Environmental Conditions and Water Quality Status and Trends

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I. INTRODUCTION AND OVERVIEW

This section presents only a very general overview of selected water quality conditions in the tidal portions of the Virginia Chesapeake Bay and its major tributary basins (Potomac, Rappahannock, York, James, and Eastern Shore). Much more comprehensive and detailed analyses are available for each major Bay basin by contacting the Department of Environmental Quality's Chesapeake Bay Program.

Water quality conditions are presented here through a combination of the current status and long-term trends for nutrients (nitrogen and phosphorus), chlorophyll, water clarity, suspended solids, and dissolved oxygen. These are the water quality indicators most directly affected by nutrient and sediment reduction strategies. Environmental information regarding other important conditions in Chesapeake Bay (e.g., submerged aquatic vegetation, fisheries, chemical contaminants) are available in a report from the Office of the Secretary of Natural Resources (Chesapeake Bay and its Tributaries: Results of Monitoring Programs And Status of Resources; 2004 Biennial Report of the Secretary of Natural Resources to The Virginia General Assembly).

The Virginia Chesapeake Bay and its tidal tributaries continue to show environmental trends indicating progress toward restoration to a more balanced and healthy ecosystem. However, the Bay system remains stressed and some areas and indicators show continuing degradation. Progress in reducing nutrient inputs has made demonstrable improvements and we expect that continued progress toward nutrient reduction goals, along with appropriate fisheries management and chemical contaminant controls, will result in additional improvements to the Bay. Findings from the last 18 years (1985 through 2002) of the monitoring programs are highlighted below and discussed further in the following sections.

- Overall, in Virginia's portion of the Chesapeake Bay drainage area, the 2002 annual nutrient loads discharged by point sources were reduced by 53% for phosphorus and 25% for nitrogen, compared to the 1985 baseline loads.

- Estimates for the delivered loads of phosphorus, nitrogen and sediment from nonpoint sources, as calculated by the Bay Program Watershed Model, have decreased by 12%, 10%, and 12%, respectively, compared to 1985 levels.

- Nutrient loads measured at watershed input monitoring stations are affected by these reduced point and nonpoint source inputs, but are highly dependant on river flow patterns as well. There have been decreased loadings of nitrogen, phosphorus, and sediments found at the James, Appomattox, and Mattaponi stations. Much of this decrease in loadings is due to lower riverflow, but loadings have also been reduced as a result of management actions.

- Phosphorus levels in water entering from the Bay watershed are reflecting both point and nonpoint source nutrient source reductions by showing improving concentration trends in some rivers. Within the tidal waters themselves, there are several areas showing improvement but also some degrading areas. Overall, there were eight areas showing improving trends and five areas showing degrading trends for phosphorus.

- For nitrogen, the Potomac and James show improving trends in water entering from the watershed. Nitrogen levels also showed improving trends in much of the tidal Potomac, James, and Elizabeth Rivers. Improving trends have also been found for the first time in the mainstem Virginia Chesapeake Bay. Degrading trends are a concern in the upper Pamunkey and Rappahannock rivers. Overall, there were nineteen areas showing improving trends and only four areas showing degrading trends for nitrogen.

- Chlorophyll concentrations (an indicator of algae levels) are moderately high throughout much of Virginia's Bay tidal waters. Degrading trends were found particularly in the tidal fresh portions of the rivers. Improving trends are being found only in the Potomac and Elizabeth Rivers. Overall, eight areas showed degrading trends in chlorophyll while two areas showed an improving trend. These results indicate nutrient concentrations are still too high despite relatively widespread improving trends in nitrogen.

- Levels of dissolved oxygen are improving in geographically widespread areas of the tidal rivers. However, an assessment of oxygen conditions in relation to recently developed criteria shows many areas of impairment. Overall, there were ten areas showing improving trends and zero areas showing degrading trends for dissolved oxygen conditions.

- Water clarity, a very important environmental parameter, was generally poor and degrading trends were detected in many areas. This degradation is probably related to scattered areas of increasing levels of suspended solids. These degrading conditions are a major impediment to restoration of submerged aquatic vegetation (SAV). Overall, there were six areas showing improving trends and ten areas showing degrading trends in water clarity.

- The Elizabeth River is showing improving trends in all major water quality parameters.

- Water quality in creeks and inlets of the Virginia Eastern Shore indicate high groundwater nutrient levels, most likely due to agricultural activities.

- In summary, there are generally improving conditions for nitrogen and dissolved oxygen. Conversely, phosphorus, chlorophyll, suspended solids, and water clarity are generally declining. These patterns are a combined result of both management controls of nutrient inputs and the natural effects of rainfall (e.g., the drought that ended in 2003).

II. TRIBUTARY BASIN NUTRIENT LOADS

A. Point Sources

Table II-1 presents the annual nitrogen and phosphorus loads discharged from the significant point sources into each of Virginia's Bay tributary basins during calendar year 2002. The table also shows the percent change in loads from 1985 to 2002.

Overall, between 1985 and 2002, the annual point source nutrient loads discharged into Virginia's Bay watershed have been reduced by 53% for phosphorus, and 25% for nitrogen. Although point source phosphorus loadings are still much lower than the 1985 baseline, they are beginning to increase slightly in recent years due to a rise in the amount of wastewater treated. The significant reductions achieved by the phosphate detergent ban and installation of chemical phosphorus removal systems (at major plants subject to the Point Source Policy for Nutrient Enriched Waters) are beginning to be offset by the increased flows. This trend is likely to continue until additional plants implement phosphorus removal or more stringent treatment levels are achieved. The total nitrogen load from point sources decreased 2% from 2001 to 2002, but a significant change was seen in the Shenandoah/Potomac basin where the load was reduced by about 15% (a 1.7 million pound/year drop). This is largely due to the start-up of biological nutrient removal (BNR) systems in 2002 at several large facilities in the northern Virginia area, including Arlington, Fairfax County, and Prince William County. It is anticipated that 2003 discharge figures will show even further reductions as these systems are fine-tuned and operated for the full year, and additional BNR projects are brought on-line (notably Alexandria and Dale Service Corporation).

Appendix A contains the 2002 nutrient loads for the significant point source dischargers tracked in each river basin in Virginia's portion of the Chesapeake Bay watershed. Plants are sorted by the percent reduction achieved since the baseline year (1985), with those achieving the highest reduction levels at the top of each list.

Table II-1. Virginia Point Source Discharged Nutrient Loads – 2002

River Basin*	Number Of Plants	2002 Phosphorus Load (lbs/yr)	Phosphorus % Change from 1985	2002 Nitrogen Load (lbs/yr)	Nitrogen % Change from 1985
Shen./Potomac	36	538,640	-29%	9,937,140	-9%
Rappahannock	18	64,580	-66%	606,550	+10%
York	10	165,020	-63%	1,203,780	-13%
James	31	1,697,100	-56%	16,290,080	-33%
Eastern Shore	4	30,500	-23%	164,260	-43%
Totals	**99**	**2,495,840**	**-53%**	**28,201,810**	**-25%**

*Note: Loads from dischargers located in the Small Western Coastal Basins are included with the nearby major tributary loads (Rappahannock includes Wicomico and N. Neck coastal; York includes Piankatank and Mobjack; James includes Poquoson, Back, Little Creek and Lynnhaven basins).

B. Nonpoint Sources

Table II-2 presents the 2002 loading estimates for phosphorus, nitrogen and sediment from nonpoint sources in each of Virginia's tributary basins. The table also shows the percent change in loads when compared to the 1985 baseline. These loading figures are based on the Year 2002 Progress Run of the Chesapeake Bay Watershed Model (Version 4.3). The Progress Scenarios provide an estimate of the projected nutrient and sediment reductions towards the cap load allocation in any given year, based on the reported cumulative implementation of control measures (nonpoint source Best Management Practices) for that year. Further, the simulation of lag times in groundwater nitrogen and sediment transport is somewhat limited in the Watershed Model, so the Progress Scenario estimates are best interpreted as a total load, assuming average hydrologic conditions, that will occur sometime in the future.

Table II-2. Virginia Nonpoint Source Delivered Nutrient & Sediment Loads – 2002

River Basin	2002 Phosphorus Load (lbs/yr)	Phosphorus % Change from 1985	2002 Nitrogen Load (lbs/yr)	Nitrogen % Change from 1985	2002 Sediment Load (tons/yr)	Sediment % Change from 1985
Shen./Potomac	1,581,040	-14%	14,462,660	-6%	720,460	-13%
Rappahannock	889,940	-18%	7,360,780	-21%	335,180	-20%
York	609,860	-17%	6,550,090	-14%	126,990	-20%
James	4,168,670	- 8%	22,165,620	- 6%	1,174,350	- 7%
Coastal	196,700	-13%	1,958,560	- 10%	22,040	-6%
Totals	**7,446,210**	**- 12%**	**52,497,710**	**- 10%**	**2,379,020**	**-12%**

III. Water Quality

Monitoring of water quality conditions is vital to understanding environmental problems, developing management strategies, and assessing progress. This section summarizes results of statistical analyses conducted on surface concentrations of total nitrogen, total phosphorus, chlorophyll, water clarity, total suspended solids and bottom measurements of dissolved oxygen. These parameters are measures of water quality that are directly influenced by changes in nutrient loading and that in turn directly affect living resources of the Bay.

Nutrients such as nitrogen and phosphorus influence the growth of phytoplankton in the water column. Elevated concentrations of these nutrients often result in excessive phytoplankton production (i.e., chlorophyll). Decomposition of the resulting excess organic material during the summer can result in low levels of dissolved oxygen in bottom waters. These low oxygen levels (anoxic or hypoxic events) can cause fish kills and drastic declines in benthic communities which are the food base for many fish populations. Anoxic waters also adversely affect fish and crab population levels by limiting the physical area available where these organisms can live.

Phosphorus: Figure 1 presents current status and long term trends in phosphorus concentrations. Areas of the **Elizabeth,** lower **James,** and **York** have the poorest conditions in relation to the rest of the Chesapeake Bay system. Other furthest downstream segments of rivers are fair but the mainstem **Chesapeake Bay** and the upper portions of the tidal rivers have relatively good conditions.

The terms *good*, *fair*, and *poor* used in conjunction with nitrogen and phosphorus conditions are statistically determined classifications for comparison among areas of similar salinity within the Chesapeake Bay system. Though useful in comparing current conditions among different areas of the Chesapeake Bay system, it must be remembered that these terms are not absolute evaluations but only appraisals relative to other areas of a generally degraded system. Several major scientific studies have shown that the Chesapeake Bay system is currently nutrient enriched and has excessive and detrimental levels of nutrient and sediment pollution. Given this, it is likely that an absolute evaluation in relation to ideal conditions would indicate that most water quality parameters are currently poor throughout the whole Bay system.

The Monitoring Subcommittee of the Federal-Interstate Chesapeake Bay Program continues to develop additional methodologies for water quality status evaluations, which in the future will be used in conjunction with, or possibly in replacement of, the current methods.

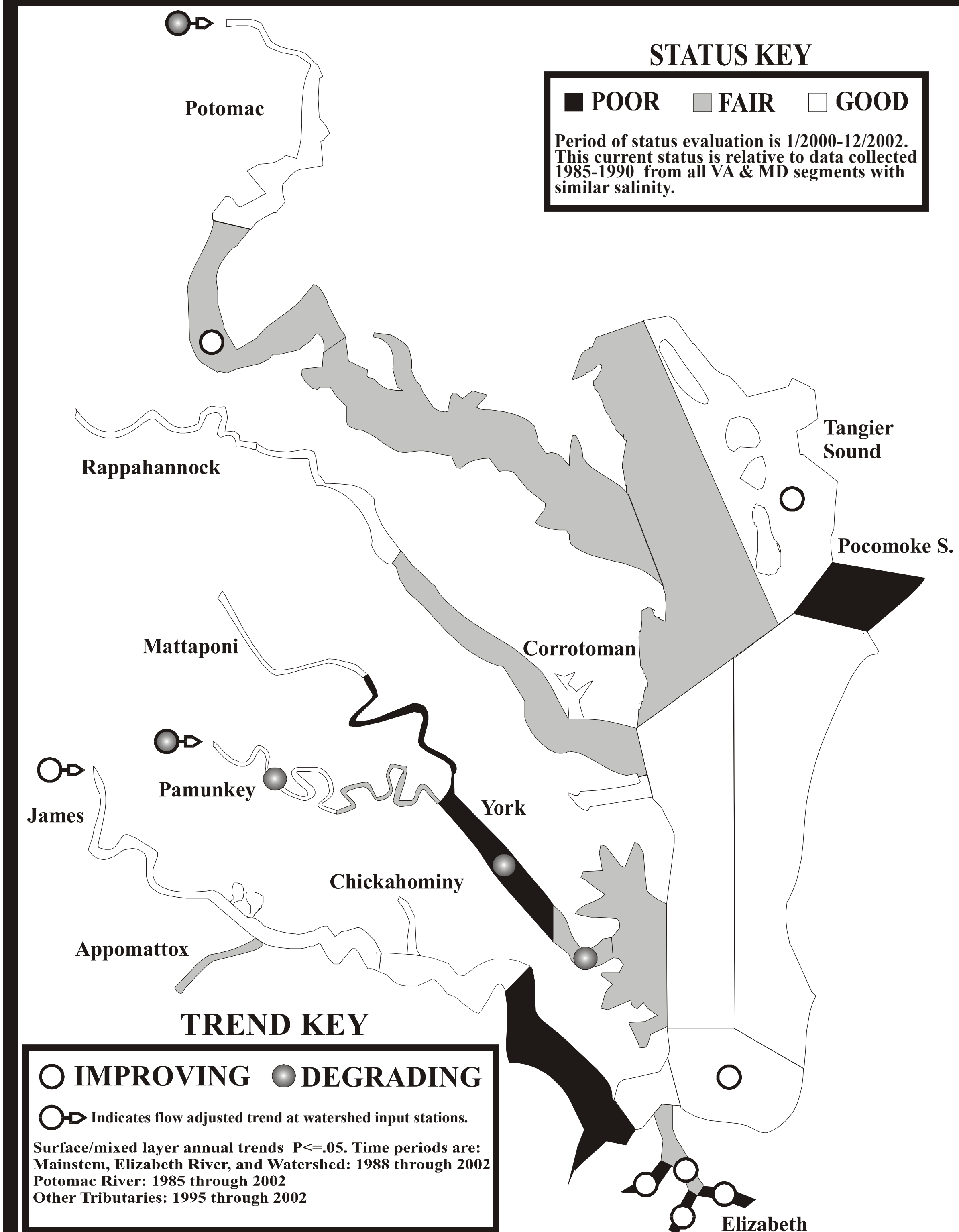
The “watershed input” stations shown in Figure 1 provide information about the success of nutrient control efforts. Results at these watershed input monitoring stations are flow-adjusted in order to remove the effects of river flow and assess only the effect of nutrient management actions (e.g., point source discharge treatment improvements and BMPs to reduce non-point source runoff).

The watershed input station in the largest Virginia tributary (**James**) shows improving concentration trends. Unfortunately, improving trends that were noted in last years report at the **Mattaponi** and **Rappahannock** watershed input stations were no longer present this year and also the degrading trends for **Pamunkey** and **Potomac** watershed inputs are still present.

The **Mattaponi**, **James**, and **Appomattox** rivers all showed declining trends in loads of phosphorus this year. These loads are highly dependent on river flow and the declining trends are partly due to the three-year drought from 1999 through 2002. The load reductions are also a result of the phosphate detergent ban as well as implementation of BMPs for the control of non-point sediment and nutrient runoff.

The degrading trend in phosphorus at the **Pamunkey** watershed input station and degrading trends in the **Pamunkey** and **York** rivers suggesting management efforts to control phosphorus runoff have not been as effective in this basin. Improving conditions for phosphorus in the **Elizabeth** River mirrors the improving trends of other major water quality conditions in the **Elizabeth** system. Though not indicated in figure 1, there were many areas of degrading phosphorus trends in the **Rappahannock** and **James** observed during 1985 through 1993. These trends are no longer present in the 1995 through 2002 time period.

Figure 1) Total Phosphorus Status and Trends



Nitrogen: Figure 2 presents status and long term trends in nitrogen concentrations. As with phosphorus, management actions to reduce nitrogen have been effective as indicated by improving trends at the **Potomac** River and **James** River watershed input stations. However, also as with phosphorus, flow-adjusted concentrations of nitrogen are degrading in the **Pamunkey** River.

The **Mattaponi**, **James**, and **Appomattox** rivers all have declining trends in loads of nitrogen. These loads are highly dependent on river flow and the declining trends are partly due to the three-year drought from 1999 through 2002. The load reductions are also a result of implementation of BMPs for the control of non-point sediment and nutrient runoff as discussed previously in section II.

The improving trend of nitrogen at the watershed input station of the **Potomac** River as well as large reductions from point sources in the Washington, D.C. area has resulted in improving trends in several tidal areas of that river. Much of the tidal **James** River has improving nitrogen trends as a result of declining loads at the river input station as well as controls on the many point sources in the Richmond-Hopewell and Hampton Roads areas. Most of the **Virginia Chesapeake Bay** and **Elizabeth** River also have improving trends in nitrogen.

Status of nitrogen in the upper **Potomac** River and parts of the **Elizabeth** River is worse than status in the other major tributaries (**Rappahannock**, **York**, and **James**) and the **Virginia Chesapeake Bay**. Much of the **Rappahannock** River, **York** River, **James** River**,** and **Virginia Chesapeake Bay** have good relative status.

Chlorophyll: Chlorophyll is a measure of the level of algal biomass (i.e., phytoplankton) in the water. High chlorophyll or algal levels are an indicator of poor water quality because they can lead to low dissolved oxygen conditions when the organic material sinks into bottom waters and is decomposed. High algal levels can also be a factor in reduced water clarity which decreases available light required to support photosynthesis in Submerged Aquatic Vegetation (SAV). High algal levels also can be indicative of problems with the food web such as decreased food quality for some fish (e.g., menhaden) and shellfish (e.g., oysters). Finally, high levels of chlorophyll may be indicative large-scale blooms of toxic or nuisance forms of algae.

Figure 3 presents the current status and long term trends in chlorophyll concentrations. Parts of all of the major Virginia tributaries have poor status in relation to Bay-wide conditions.

Degrading trends in chlorophyll were detected in the upper tidal fresh portions of the **Potomac**, **Rappahannock**, **James**, and **Appomattox** rivers. The only improving trends were observed in the lower **Potomac** River and part of the **Elizabeth** River.

Dissolved Oxygen: Bottom dissolved oxygen is an important factor affecting the survival, distribution, and productivity of living resources in the aquatic environment. Figure 4 presents the current status and long term trends in dissolved oxygen concentrations. Status is given in relation to dissolved oxygen levels supportive or stressful to living resources. About half of the Virginia **Chesapeake Bay** and smaller portions of the tidal tributaries had only fair status. The lower **Potomac River**, lower **Rappahannock River**, lower **York River**, and northernmost

Virginia Chesapeake Bay segments are indicated as poor or fair partly because of low dissolved oxygen concentrations found in the mid-channel trenches. These mid-channel trenches have naturally lower dissolved oxygen levels and the spatial and temporal extent of low dissolved oxygen levels has been exacerbated by anthropogenic nutrient inputs.

There are scattered areas of improving conditions for dissolved oxygen and no areas of degrading trends. All of the tributaries except the **Potomac** have areas of improving conditions. These improvements are a result of both the nutrient management efforts and natural factors. The major natural factor has been the long-term (i.e. 1985 through 2003) declining riverflow at the watershed input stations of the Rappahannock, **Pamunkey**, **Mattaponi**, **James**, and **Appomattox** rivers. This in turn has lead to naturally less nutrient inputs and concurrently higher influxes of cleaner oceanic water.

Figure 2) Total Nitrogen Status and Trends

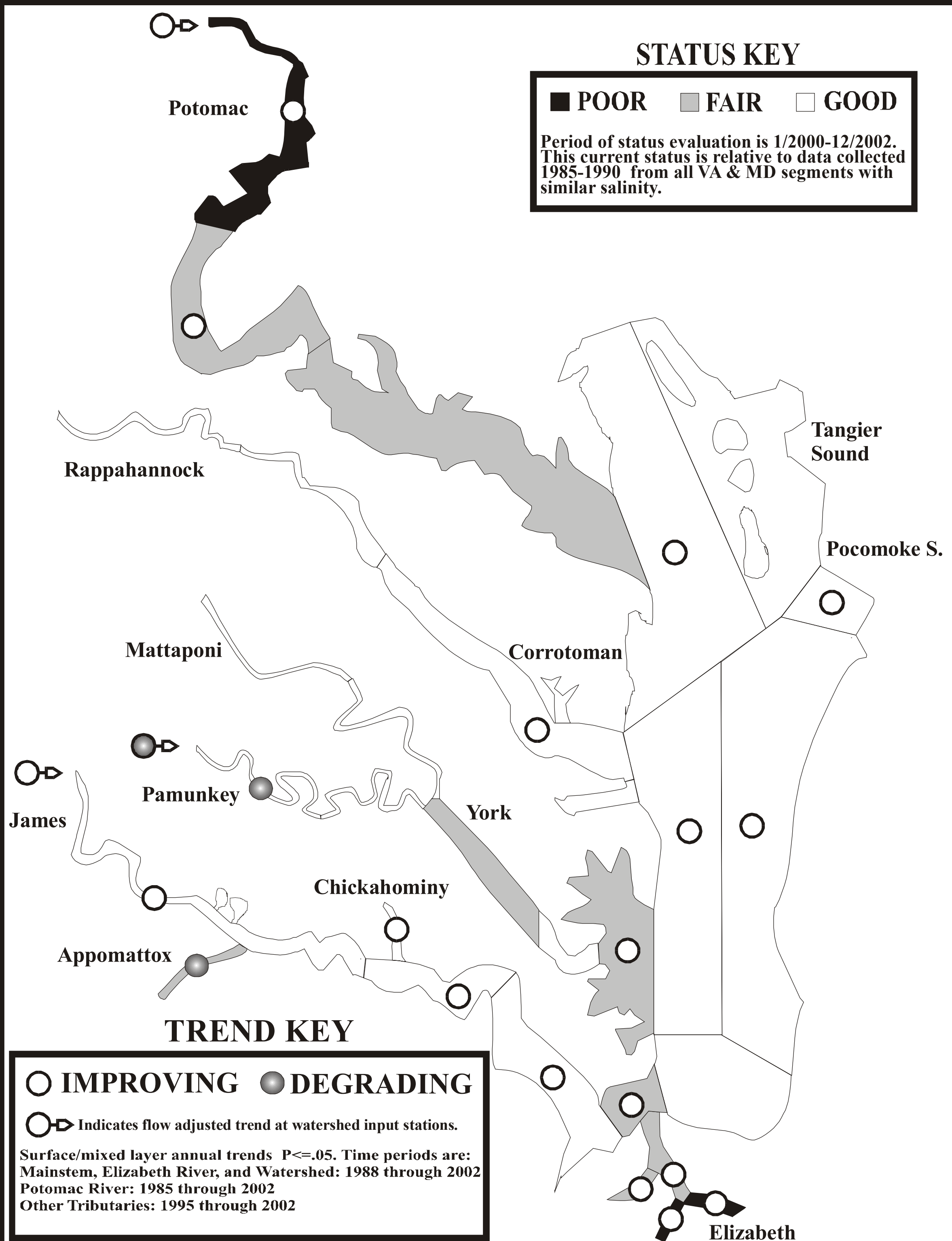
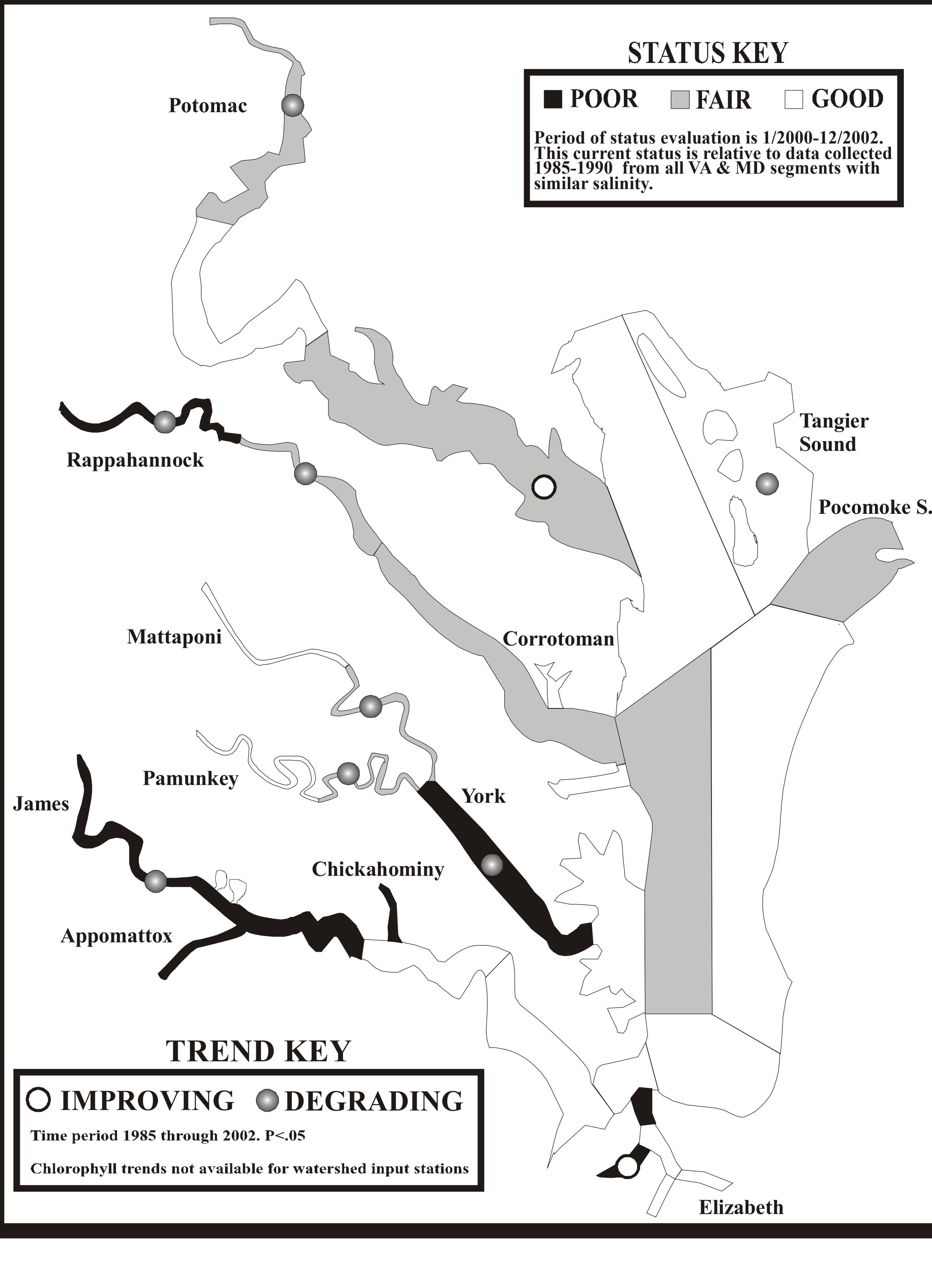


Figure 3) Chlorophyll Status and Trends



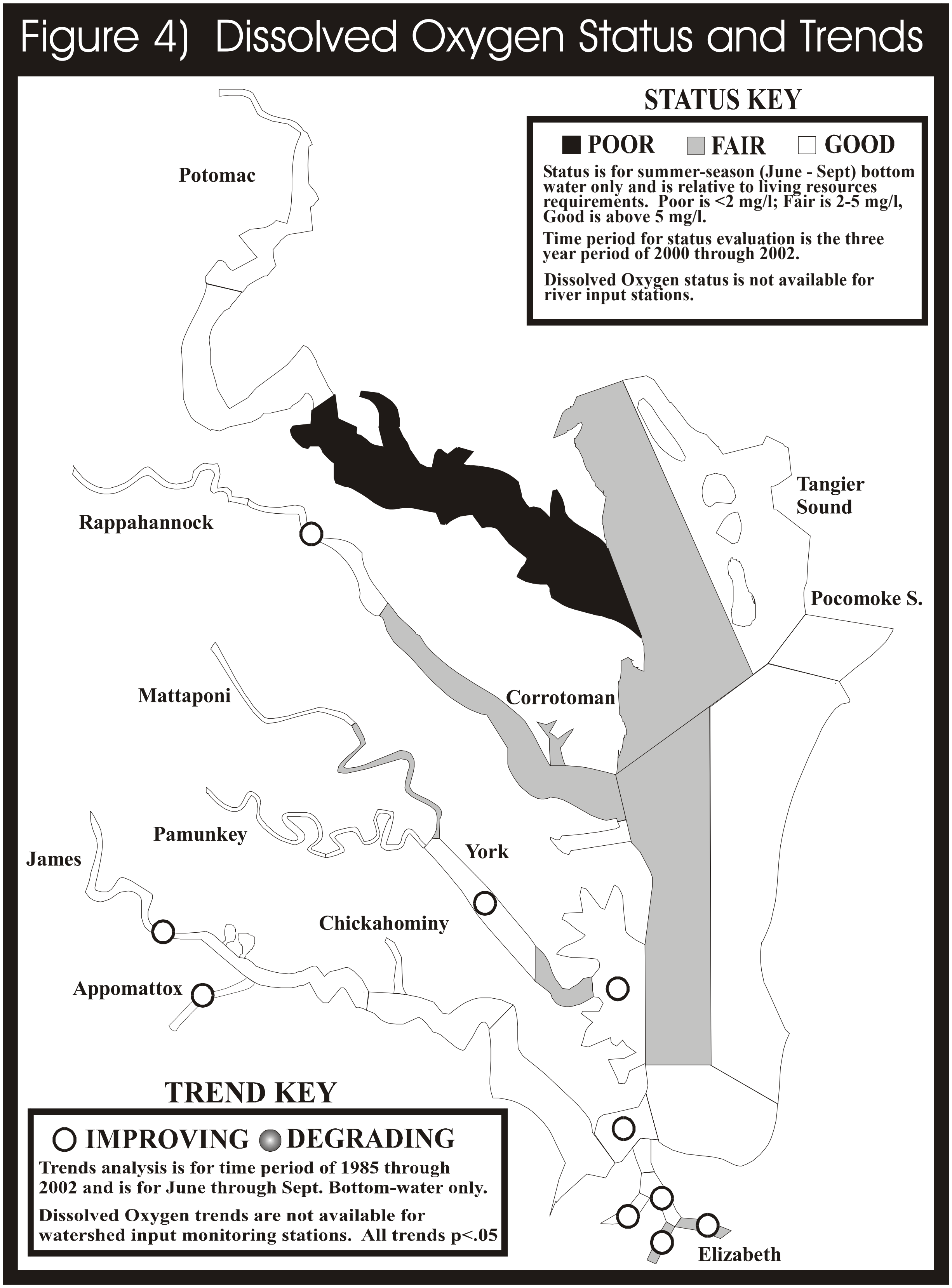


Figure 4) Dissolved Oxygen Status and Trends
STATUS KEY
POOR
FAIR
GOOD
Status is for summer-season (June - Sept) bottom water only and is relative to living resources requirements. Poor is <2 mg/l; Fair is 2-5 mg/l, Good is above 5 mg/l.
Time period for status evaluation is the three year period of 2000 through 2002.
Dissolved Oxygen status is not available for river input stations.
Potomac
Rappahannock
Tangier Sound
Pocomoke S.
Mattaponi
Corrotoman
Pamunkey
James
York
Chickahominy
Appomattox
Elizabeth
TREND KEY
IMPROVING
DEGRADING
Trends analysis is for time period of 1985 through 2002 and is for June through Sept. Bottom-water only.
Dissolved Oxygen trends are not available for watershed input monitoring stations. All trends p<.05

Dissolved Oxygen in relation to new Bay criteria: The Chesapeake Bay 2000 agreement committed to, by 2010, "correct the nutrient- and sediment-related problems in the Chesapeake Bay and its tidal tributaries sufficiently to remove the Bay and the tidal portions of its tributaries from the list of impaired waters under the Clean Water Act."

The first step in this process was to define the appropriate regulatory criteria by which the Bay can be assessed. To this end, the U.S. Environmental Protection Agency (EPA) Region III developed a guidance document, entitled "Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries (April 2003)". This document presents the EPA's proposed regional-based nutrient and sediment enrichment criteria expressed as dissolved oxygen, water clarity and chlorophyll a criteria, applicable to the Chesapeake Bay and its tidal tributaries. Various stakeholder groups were involved in their development, with contributions from staff of federal and state governments, local agencies, scientific institutions, citizen conservation groups, business and industry.

Current Virginia water quality standards require a monthly average 5 mg liter^{-1} of dissolved oxygen throughout all of the Bay's waters – from the deep trench near the Bay's mouth to the shallows at the head of the Bay. Even though the 5 mg liter^{-1} standard is Bay-wide, scientists believe natural conditions dictate that in some sections of the Bay, such as the deep channel, Bay waters cannot achieve the current 5 mg liter^{-1} standard during the warmer months of the year. Additionally, scientists believe other areas, such as prime migratory fish spawning areas, require higher levels of dissolved oxygen to sustain life during the late winter to early summer time frame. The amount of oxygen needed in the Bay tidal waters depends on specific needs of the aquatic living resources, where they live, and during which time of the year they live there. Because of these factors, five revised Chesapeake Bay tidal water designated uses were developed to more fully reflect the different aquatic living resource communities inhabiting a variety of habitats and, therefore, the different intended aquatic life uses of those tidal habitats. The habitat designated uses are described below and graphically depicted in Figure 5.

Migratory Fish Spawning and Nursery Designated Use: Aims to protect migratory finfish during the late winter/spring spawning and nursery season in tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay and will benefit several species including striped bass, perch, shad, herring and sturgeon.

Shallow Water Designated Use: Designed to protect underwater Bay grasses and the many fish and crab species that depend on the shallow-water habitat provided by grass beds.

Open-Water Fish and Shellfish Designated Use: Designed to protect water quality in the surface water habitats within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round. This use aims to protect diverse populations of sport-fish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the listed shortnose sturgeon.

Deep-Water Seasonal Fish and Shellfish Designated Use: Aims to protect living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. This use protects many bottom-feeding fish, crabs and oysters, as well as other important species, including the bay anchovy.

Deep Channel Seasonal Refuge Designated Use: Designed to protect bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer. The deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

Figure 5) Conceptualized illustration of the five Chesapeake Bay tidal water Designated Use zones

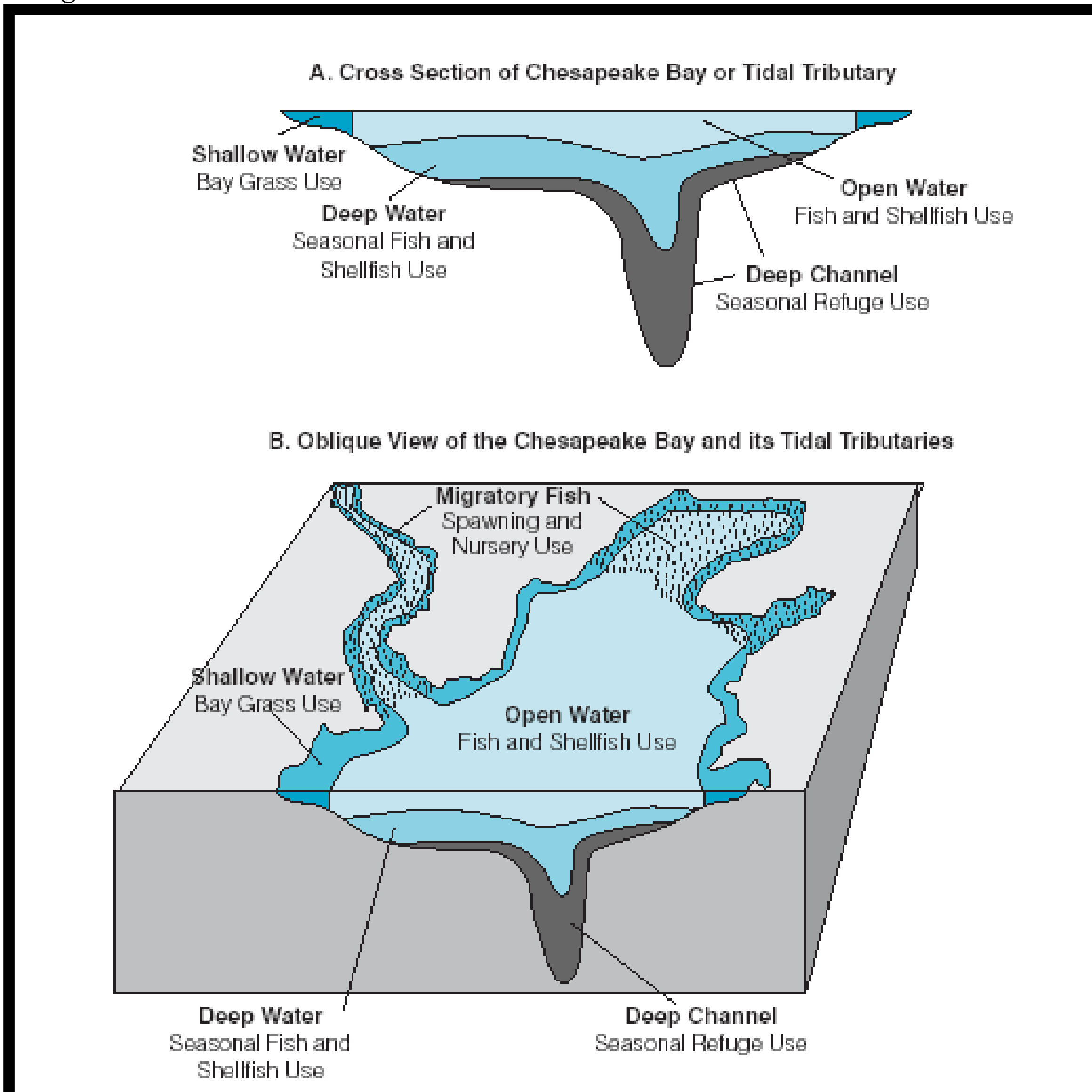


Table 1. Chesapeake Bay dissolved oxygen criteria.

Designated Use	Criteria Concentration/Duration	Protection Provided	Temporal Application
Migratory fish spawning and nursery use	7-day mean $\geq$ 6 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Survival/growth of larval/juvenile tidal-fresh resident fish.; protective of threatened/endangered species.	February 1 - May 31
	Instantaneous minimum $\geq$ 5 mg liter^{-1}	Survival and growth of larval/juvenile migratory fish; protective of threatened/endangered species.	
	Open-water fish and shellfish designated use criteria apply		June 1 - January 31
Shallow-water bay grass use	Open-water fish and shellfish designated use criteria apply		Year-round
Open-water fish and shellfish use	30-day mean $\geq$ 5.5 mg liter^{-1} (tidal habitats with 0-0.5 ppt salinity)	Growth of tidal-fresh juvenile and adult fish; protective of threatened/endangered species.	Year-round
	30-day mean $\geq$ 5 mg liter^{-1} (tidal habitats with >0.5 ppt salinity)	Growth of larval, juvenile and adult fish and shellfish; protective of threatened/endangered species.	
	7-day mean $\geq$ 4 mg liter^{-1}	Survival of open-water fish larvae.	
	Instantaneous minimum $\geq$ 3.2 mg liter^{-1}	Survival of threatened/endangered sturgeon species.[1]	
Deep-water seasonal fish and shellfish use	30-day mean $\geq$ 3 mg liter^{-1}	Survival and recruitment of bay anchovy eggs and larvae.	June 1 - September 30
	1-day mean $\geq$ 2.3 mg liter^{-1}	Survival of open-water juvenile and adult fish.	
	Instantaneous minimum $\geq$ 1.7 mg liter^{-1}	Survival of bay anchovy eggs and larvae.	
	Open-water fish and shellfish designated-use criteria apply		October 1 - May 31
Deep-channel seasonal refuge use	Instantaneous minimum $\geq$ 1 mg liter^{-1}	Survival of bottom-dwelling worms and clams.	June 1 - September 30
	Open-water fish and shellfish designated use criteria apply		October 1 - May 31

[1] At temperatures considered stressful to shortnose sturgeon (>29°C), dissolved oxygen concentrations above an instantaneous minimum of 4.3 mg liter^{-1} will protect survival of this listed sturgeon species.

The newly proposed dissolved oxygen criteria to protect these uses are shown in Table 1. The proposed methodology for assessing monitoring data against these criteria is very different than has traditionally been used for regulatory criteria. It involves a spatial interpolation of fixed site monitoring results to create a complete 3-D picture of oxygen conditions of thousands of individual grid cells throughout the Bay. Each individual grid cell is then assessed against the criteria. In this way, the volume of water in attainment is calculated for each data collection cruise and a "spatial" assessment achieved. In order to account for naturally induced fluctuations over seasons and years, the individual spatial assessments of a three-year time period are aggregated, creating a "temporal" viewpoint. The final assessment involves examining the cumulative frequency distribution (CFD) of attainment from the aggregated data. In this way, a combined "space-time" assessment is achieved which allows a much more detailed analysis of conditions.

Figure 6 shows an evaluation of where these criteria are attained based upon an analysis using the CFD approach on data collected during of the time period of 1984 through 1995.

- Full attainment of the criteria was achieved throughout the **James** river as well as parts of the **Potomac**, **Rappahannock**, and Virginia **Chesapeake Bay**

- Open water use areas of the middle **Potomac**, Lower **Rappahannock**, lower **York**, **Elizabeth** River, and much of the Virginia **Chesapeake Bay** show the lowest violation rates ranging from 1-10%. Deep water use zones of the mainstem **Chesapeake Bay** and lower **Potomac** River also show a violation rate of 1-10%.

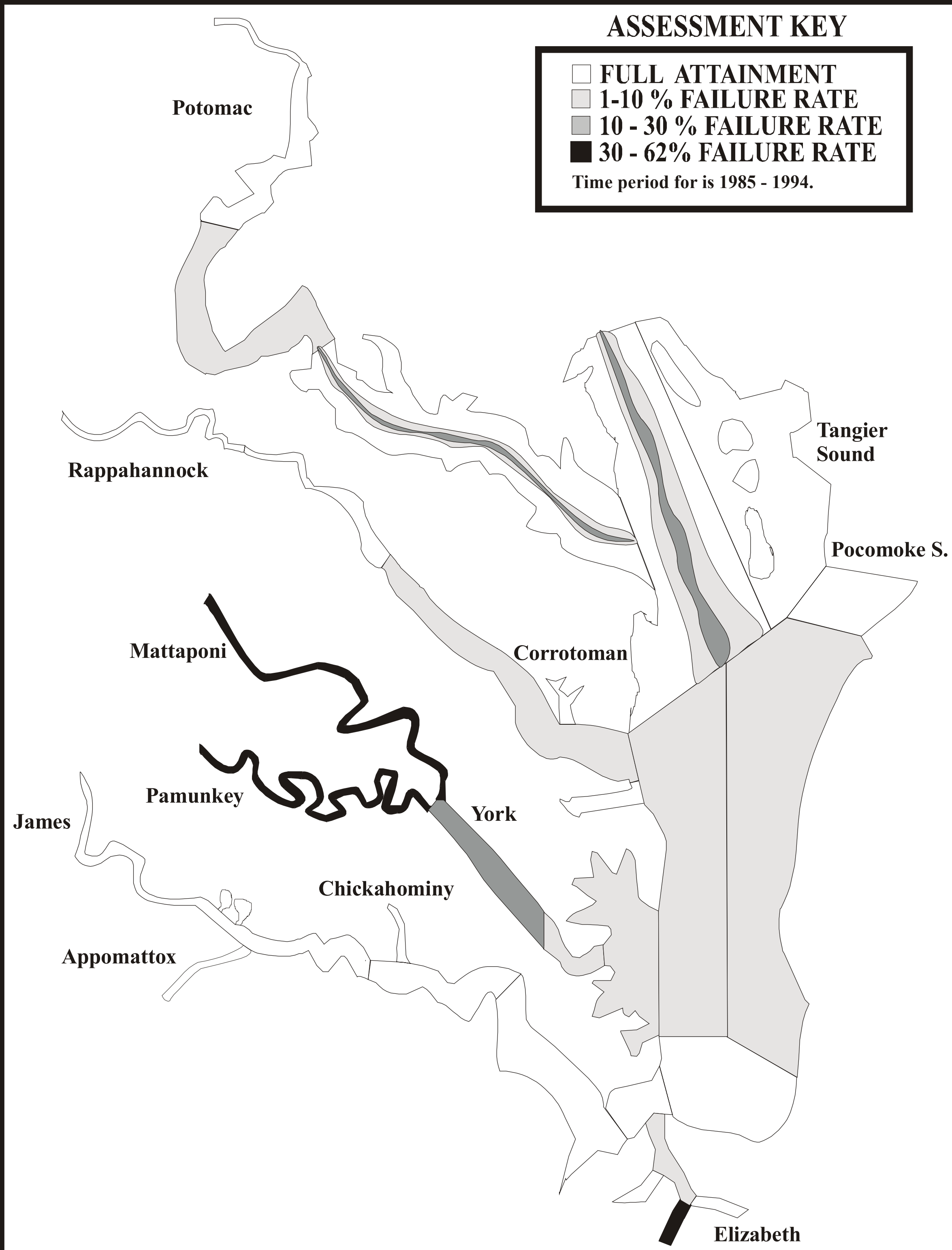
- Higher violation rates (10-30%) are found in the deep channel use zones of the lower **Potomac** and mainstem **Chesapeake Bay** segments.

- Quite high exceedance rates (30-60%) are observed in the **Mattaponi**, **Pamunkey**, and Southern Branch of the **Elizabeth**.

- Predictive computer modeling suggests that if the nutrient and sediment allocations discussed in section II are met, then all these segments should come into attainment of the new criteria.

There are several caveats to this assessment. First, it is recognized that some portion of the exceedences found in the **Mattaponi** and **Pamunkey** Rivers are due to natural influence of the extensive fringing wetlands. Therefore these rivers may need special modification to either the criteria or assessment protocols when determining if these areas are regulatory impaired. Secondly, this assessment presented has used a ten-year data period (i.e. 1985 – 1995) and is not reflective of current conditions or the proposed three-year data period (i.e. 2000 – 2003). Finally, the complete regulatory assessment methodology (including final criteria numbers and data analysis tools) is still under development. It is expected that these will be finalized during 2004. Despite these caveats, this demonstrates the new process that will be used in defining a realistic regulatory framework for Chesapeake Bay restoration.

Figure 6) Dissolved Oxygen Criteria Attainment



Water Clarity: Water clarity is a measure of the depth to which sunlight penetrates through the water column. Poor water clarity is an indication that conditions are inadequate for the growth and maintenance of submerged aquatic vegetation (SAV). Poor water clarity can also affect the health and distributions of fish populations by reducing their ability to capture prey or avoid predators. The major factors that affect water clarity include: 1) concentrations of particulate inorganic mineral particles (i.e., sand, silt and clays), 2) concentrations of algae (i.e., phytoplankton), 3) concentrations of particulate organic detritus (small particles of dead algae and/or decaying marsh grasses), and 4) dissolved substances which "color" the water (e.g., brown humic acids generated by plant decay). Which of these factors most greatly influence water clarity varies both seasonally and spatially.

Figure 7 presents the current status and long term trends in water clarity. Status of many segments within the tributaries and the **Chesapeake Bay** mainstem are only fair or poor. This suggests that poor water clarity is one of the major environmental factors inhibiting the resurgence of SAV growth in **Chesapeake Bay**.

Degrading trends in water clarity were detected in segments located over a wide geographic area within the Virginia tributaries and **Virginia Chesapeake Bay**. These degrading trends represent a substantial impediment to the recovery of SAV beds within **Chesapeake Bay**. Possible causes of the degrading trends included increased shoreline erosion as a result of waterside development, loss of wetlands, increased abundance of phytoplankton, or a combination of sea level rise and land subsistence.

Water Clarity in relation to new Bay criteria: As discussed previously for dissolved oxygen, there have recently been new criteria for water clarity developed and published by EPA ("Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries (April 2003)". These criteria are expressed as either secchi depth or "percent light through water" and shown in table 2.

Figure 7a shows an evaluation of where these criteria are attained based upon an analysis using the previously discussed CFD approach on data collected during of the time period of 1984 through 1995.

- Full attainment of the criteria is evident in the **James** and **York** rivers, upper **Rappahannock**, and parts of the **Virginia Chesapeake Bay**.

- The worst area of attainment is in the upper **Potomac** River where there is 73-75% failure rate.

- Lower levels of failure (1-50%) are found in the lower **Potomac**, much of the **Virginia Chesapeake Bay**, lower **Rappahannock**, and **Mobjack** Bay.

There are several caveats to this assessment. First, this assessment presented has used a ten-year data period (i.e. 1985 – 1995) and is not reflective of current conditions or the proposed three-year data period (i.e. 2000 – 2003). Second, the complete regulatory assessment methodology (including final water clarity criteria numbers and data analysis tools) is still under development and expected to be finalized during 2004. Third is that missing from this assessment a consideration of where current levels of submerged aquatic plants are indicative of good water clarity. It is likely that the final regulatory assessment framework will include this factor as a major determinant of water clarity achievement. Despite these caveats, this presentation demonstrates some of the new process that will be used in defining a realistic regulatory framework for Chesapeake Bay restoration.

Suspended Solids: Suspended solids are a measure of particulates in the water column including inorganic mineral particles, planktonic organisms and detritus which directly controls water clarity for SAV. Elevated suspended solids can also be detrimental to the survival of oysters and other aquatic animals. Young oysters can be smothered by deposition of material and the feeding of filter feeding fish such as menhaden can be negatively affected by high concentrations of suspended solids. In addition, since suspended solids is comprised of organic and mineral particles that contain nitrogen and phosphorus or to which nitrogen and phosphorus compounds are adsorbed, increases in suspended solids can result in an increase of nutrient concentrations.

Figure 8 presents the current status and long term trends in suspended solids concentrations. All of the major Virginia tributaries have segments that are fair or poor. Improving trends in flow-adjusted concentrations at the watershed input stations of the **Potomac River** and the **James River** suggest that management actions to reduce NPS sediment loads may be working in these basins. However, several degrading trends in suspended solids concentrations were detected in some segments in both the tributaries and the **Virginia Chesapeake Bay** mainstem. The **York** River system (i.e. **Mattaponi**, **Pamunkey**, **and York**) has particularly widespread degrading conditions for suspended solids.

Table 2. Summary of Chesapeake Bay water clarity criteria for application to shallow-water bay grass designated use habitats.

Salinity Regime	Water Clarity Criteria as Percent Light-through-Water	Water Clarity Criteria as Secchi Depth								Temporal Application
		Water Clarity Criteria Application Depths								
		0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	
		Secchi Depth (meters) for Above Criteria Application Depth								
Tidal fresh	13%	0.2	0.4	0.5	0.7	0.9	1.1	1.2	1.4	April 1 - October 31
Oligohaline	13%	0.2	0.4	0.5	0.7	0.9	1.1	1.2	1.4	April 1 - October 31
Mesohaline	22%	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	April 1 - October 31
Polyhaline	22%	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	March 1 - May 31, September 1 - November 30

Figure 7) Water Clarity Status and Trends

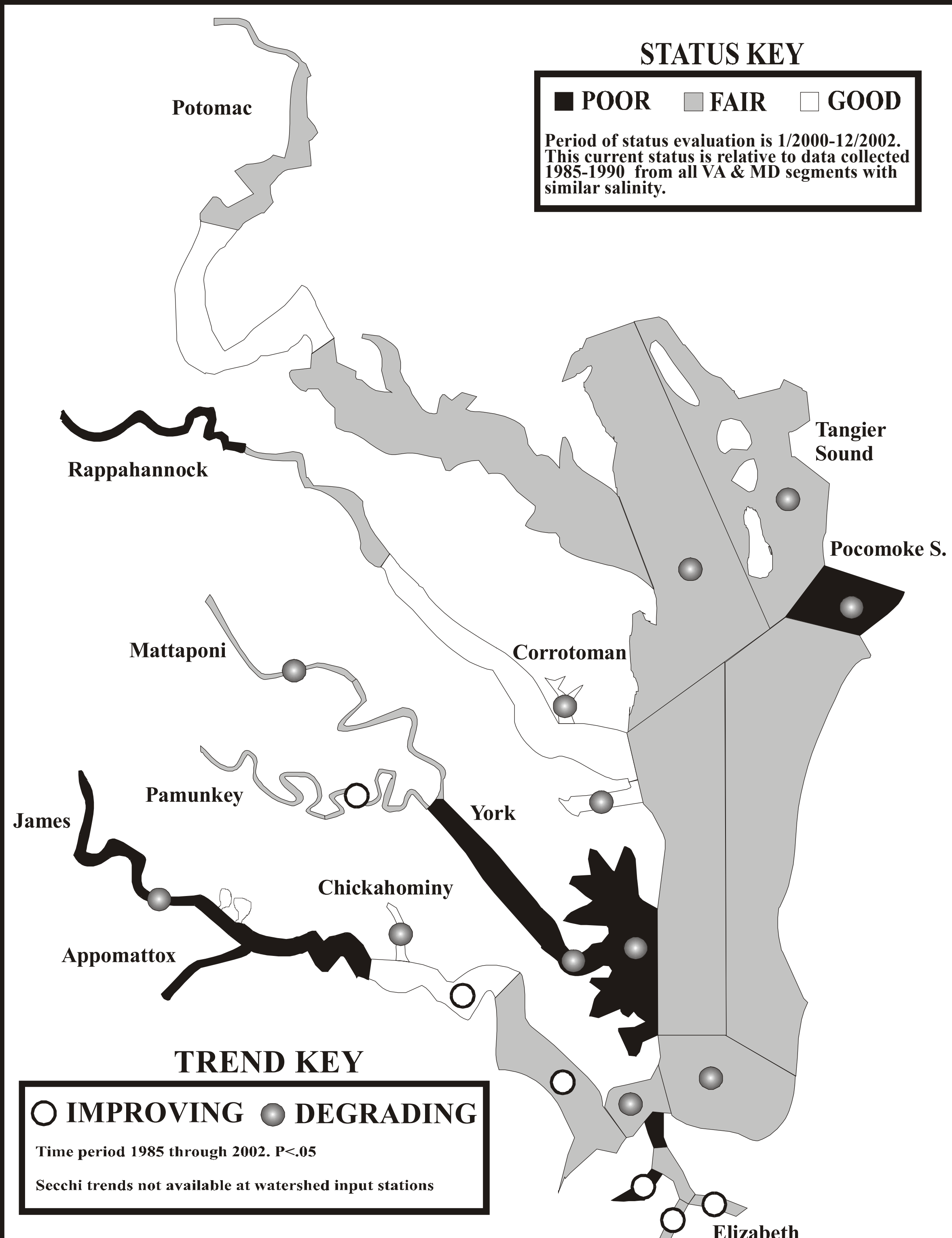
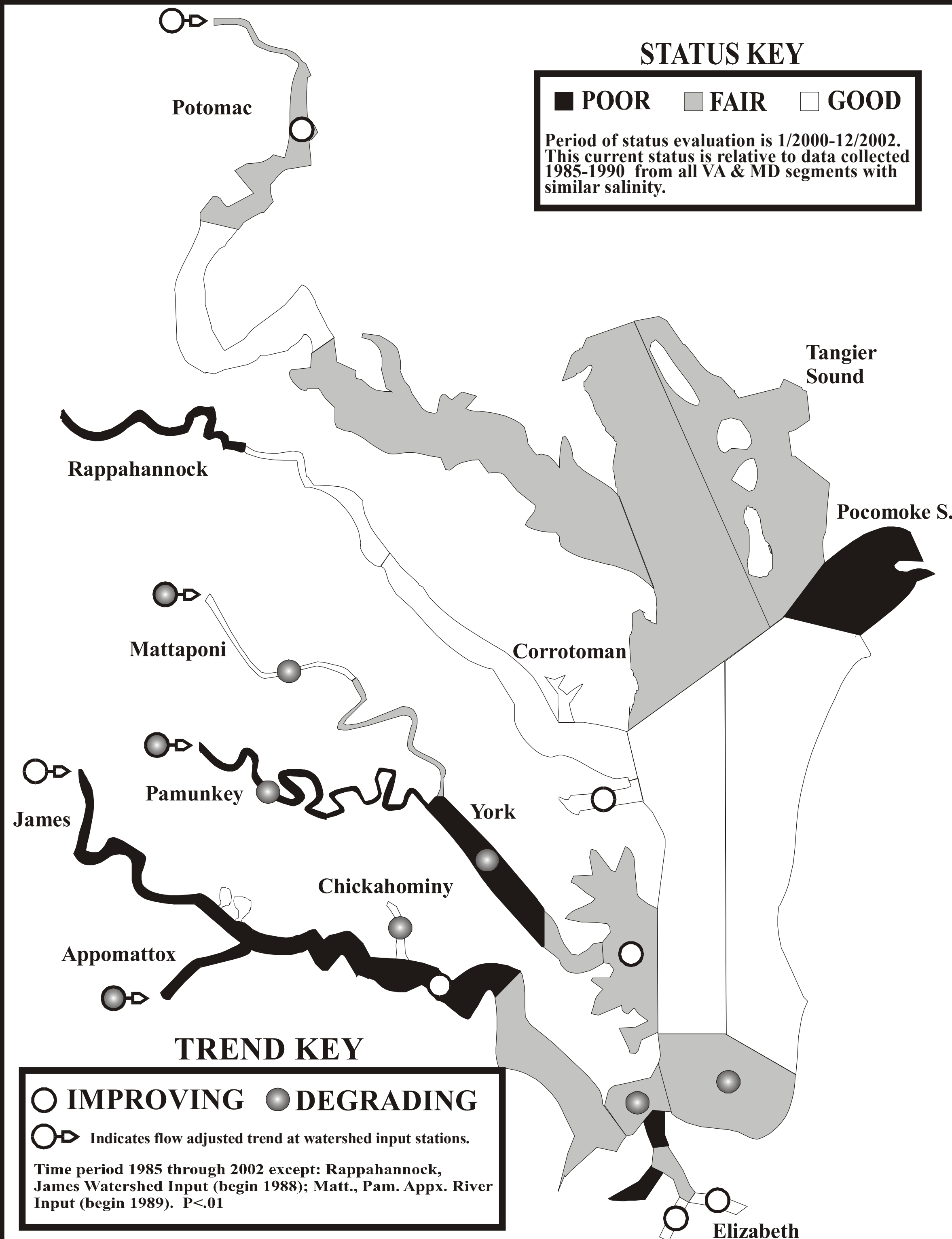


Figure 7a) Water Clarity Criteria Attainment

Figure 8) Suspended Solids Status and Trends



Water Quality on the Eastern Shore

The Eastern Shore of Virginia is an 80-mile long peninsula that has approximately 1/2 of its 696 square miles draining into the Chesapeake Bay. Watersheds on Virginia's Eastern Shore are primarily composed of relatively complex bayside inlets and creeks systems that are often shallow and tidally well mixed (Figure 9).

Figure 9. Virginia's Eastern Shore Peninsula.

Image downloaded from the schoolyard LTER website of the Virginia Coastal Reserve Long Term Ecological Research Program.

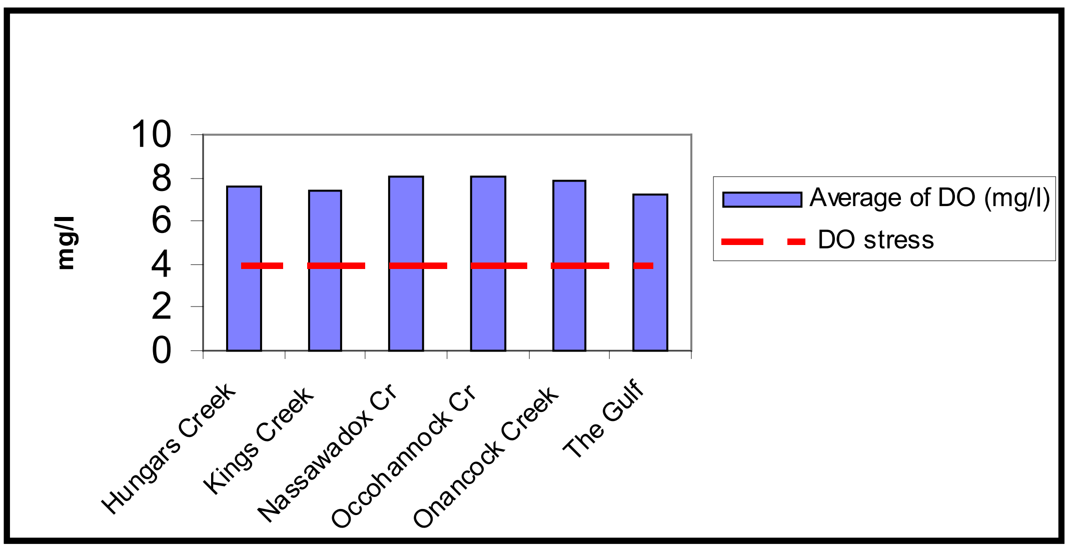
Six sites on Virginia's Eastern Shore monitored during 2002 were located in areas considered historically important habitats for submerged aquatic vegetation (SAV): Hungars Creek, Kings Creek, Nassawadox Creek, Occohannock Creek, Onancock Creek and The Gulf, each had one station monitored in an SAV habitat (Table 3).

Table 3. Station locations for DEQ stations monitored in historically important Chesapeake Bay SAV habitats.

Stream Name	Storet Station Name
Hungar's Creek	7-HUG001.24
King's Creek	7-KNS000.40
Nassawadox Creek	7-NSS001.62
Occohannock Creek	7-OCH001.60
Onancock Creek	7-OCN001.92
The Gulf	7-THG000.36

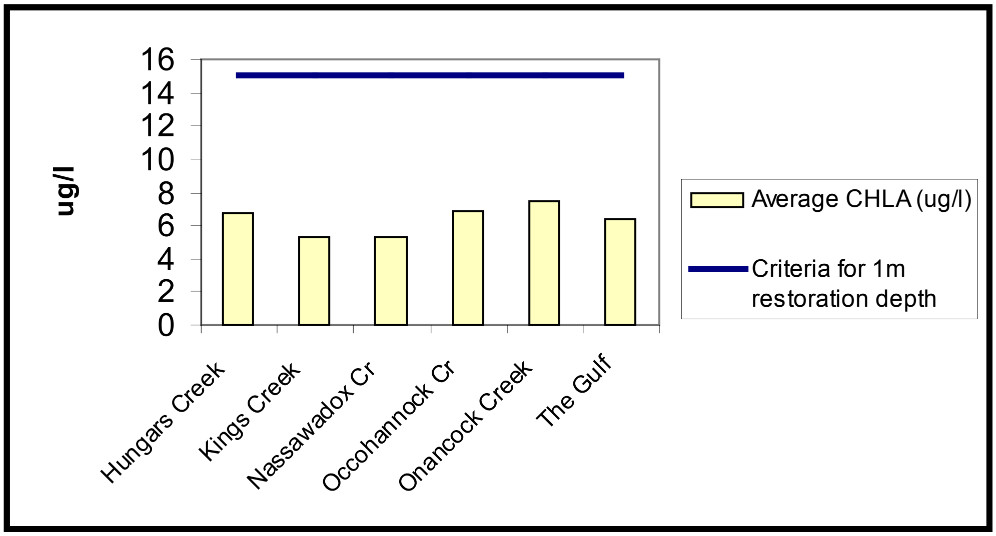
Oxygen: Average Dissolved Oxygen concentrations were similar at all stations located in SAV habitats and well above the water quality criteria of 5 mg/L at all stations during periods considered critical to living resources (Figure 10).

Figure 10) 2002 Average Dissolved Oxygen Concentrations (May-March and September-November).



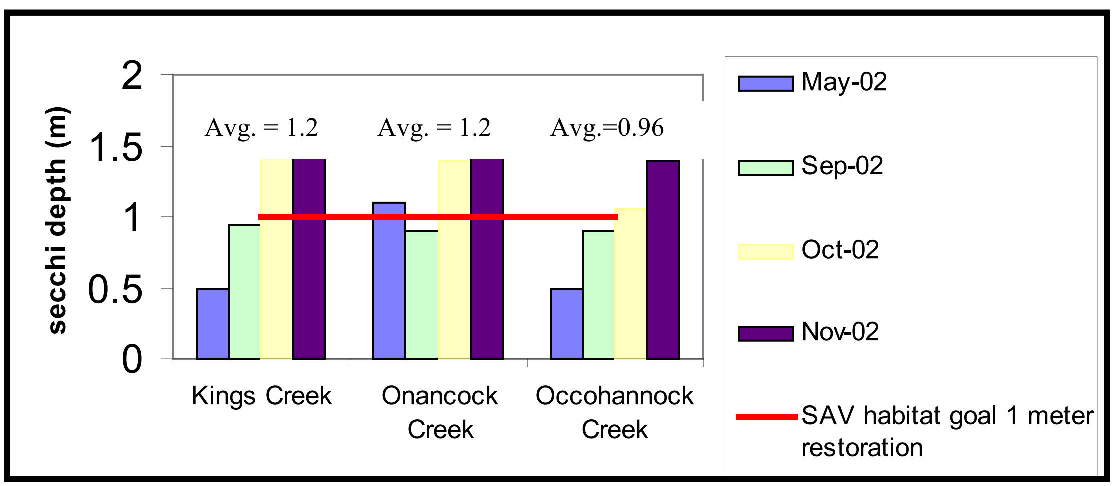
Chlorophyll: The annual average target for Chlorophyll a for 1-Meter restoration of SAV was also met on all creeks located in historically important SAV habitats during 2002 (Fig 11).

Figure 11) 2002 Average Chlorophyll a Concentrations (May-March and September-November).



Water clarity: Three of the DEQ stations monitored in the SAV habitat areas had water clarity data associated with them (Figure 12). Average secchi depths during SAV growth season for Kings Creek and the Onancock Creek met the SAV criteria for 1-meter restoration while the Occohannock Creek did not. However, at each site the water clarity did not meet the 1-meter restoration criteria during some of the months sampled during the SAV growth season.

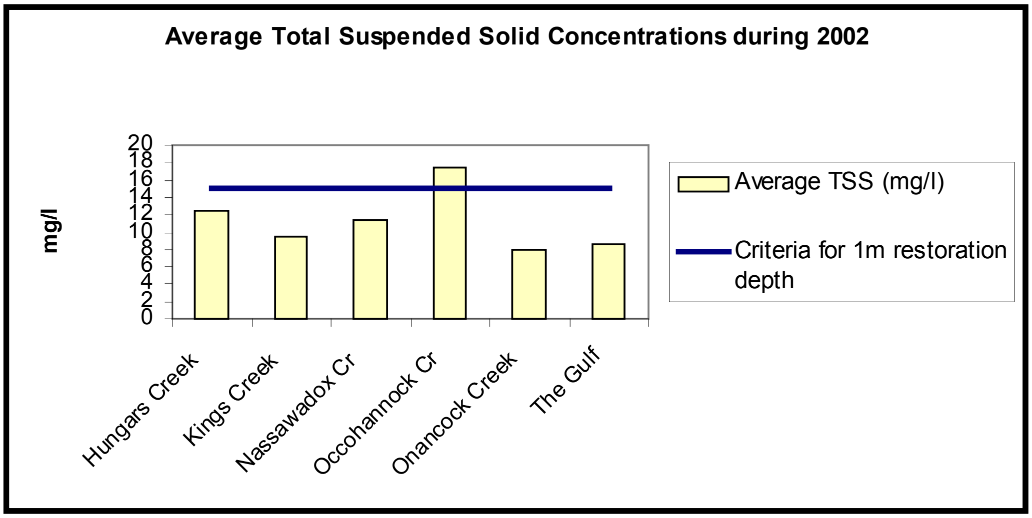
Figure 12) Eastern Shore Water Clarity 2002 (May-March and September - November).



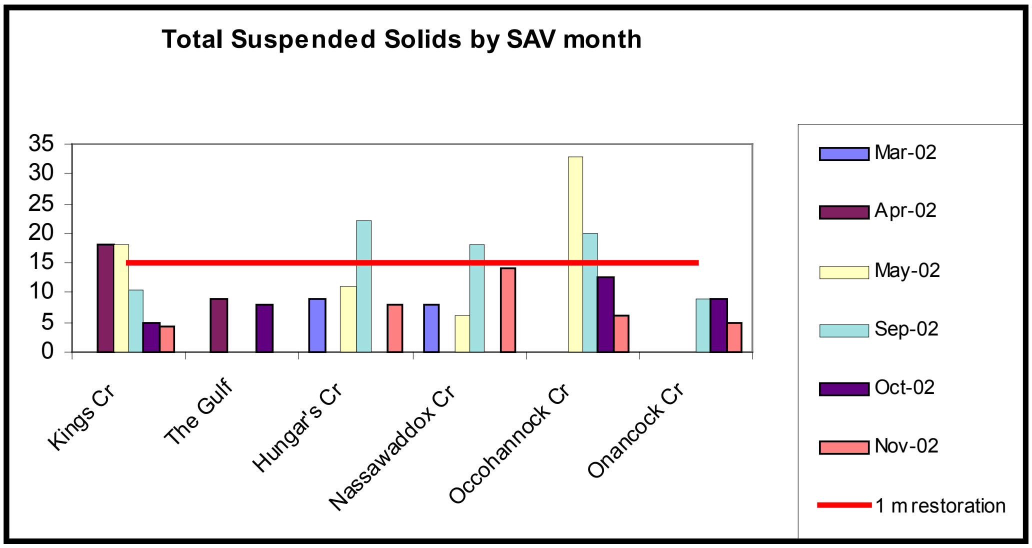
Suspended Solids: With the exception of the station located in the Occohannock Creek, average Total Suspended solid concentrations for stations located in SAV habitats met the Criteria for 1-

Figure 13)Suspended Solid Concentrations for 2002.

a. Average concentrations for suspended solids for the SAV growing season (May - March and September - November).



b. Average concentrations by month of collection for suspended solids for the SAV growing season (May - March and September - November).

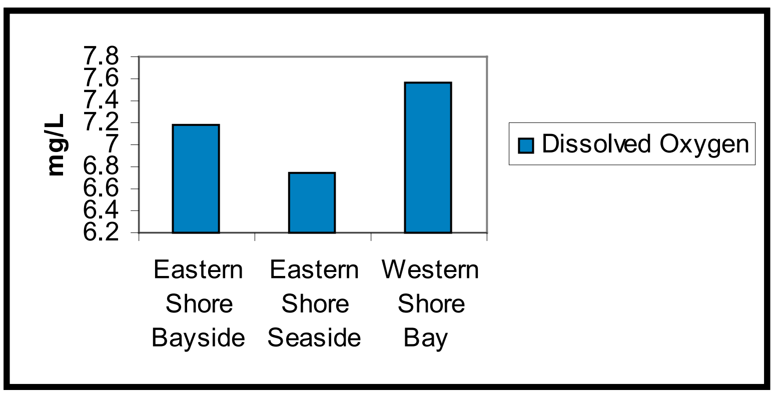


meter restoration goal (Fig 13a). However, as with water clarity, four of the six stations did not meet the criteria during one or more of the months considered critical to SAV growth in 2002 (Fig 13b). Suspended solid concentrations can vary greatly depending on the levels of wind mixing of inorganic mineral particles, planktonic organisms and detritus suspended in the water column. This variation may explain why SAV growth period averages for DEQ monitored stations appear to contrast results reported previously in the 2002 Annual Report for a study conducted by the Virginia Institute of Marine Science (VIMS). The VIMS study was conducted during 2001 - 2002 and average TSS concentrations at three sites each on Cherrystone inlet, Hungar's Creek and Old Plantation Creek and at one site each on the Occohannock, Onancock and Chesconessex Creeks did not meet the criteria for 1-meter restoration during 2002.

In 2002 DEQ monitored 89 sites on 60 creeks of the Eastern Shore as part of its long-term ambient water quality monitoring program and special studies. Thirty-nine of those sites are located in tidal creeks draining into the Chesapeake Bay with the remaining 50 sites located in tidal creeks and embayments draining into the Atlantic Ocean.

Figure 14 contrasts the average dissolved oxygen concentrations for the Eastern Shore Chesapeake Bay coastal stations (Eastern Shore Bayside), Eastern Shore Atlantic coastal

Figure 14) 2002 Dissolved Oxygen Concentrations.



stations (Eastern Shore Seaside) and stations in the Western shore creeks of the Chesapeake Bay (Western Shore Bay). Average concentrations were well above levels considered stressful to aquatic life in each station grouping. Concentrations were highest in Western Shore Bay stations and lowest in the Eastern Shore Seaside stations where low dissolved oxygen concentrations most likely occur due to the decomposition of organic matter produced in the very extensive marsh wetlands there.

The average concentration of suspended solids was comparable for the Eastern Shore Bayside tributaries and the Western Shore Bay with highest suspended solid concentrations occurring in the Seaside locations (Figure 15). These high suspended solids levels in the seaside stations are likely due to natural continual resuspension of materials from the extensive marsh surfaces and shallow water lagoons through a combination of tidal forces and wind.

Figure 15) 2002 Suspended Solids

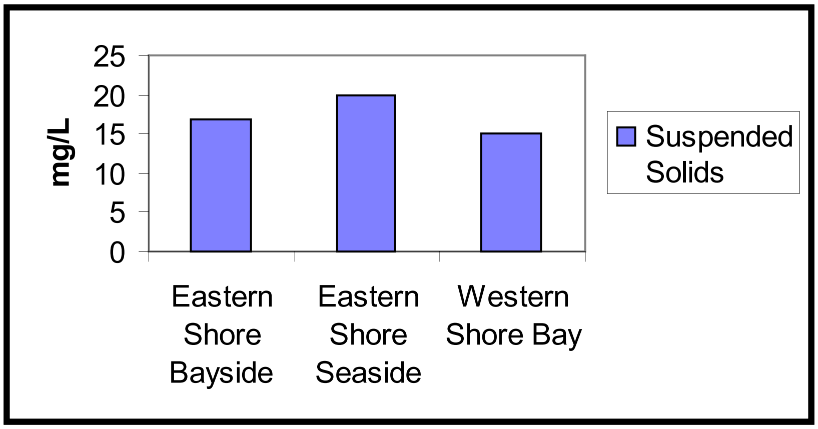
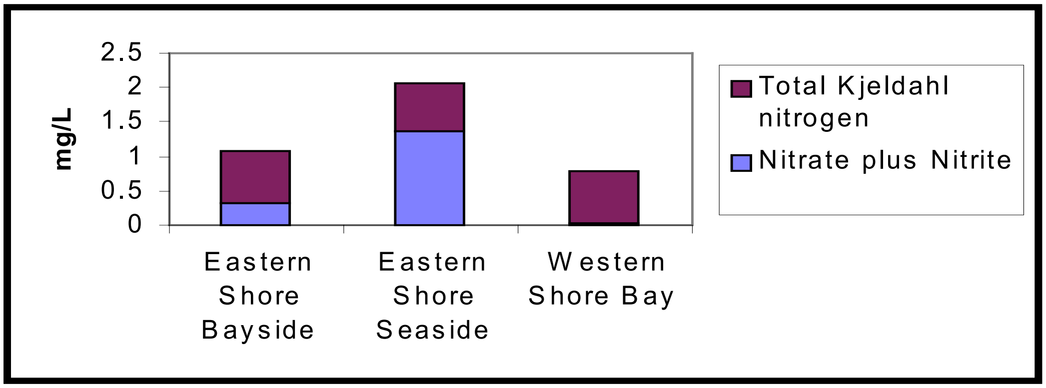


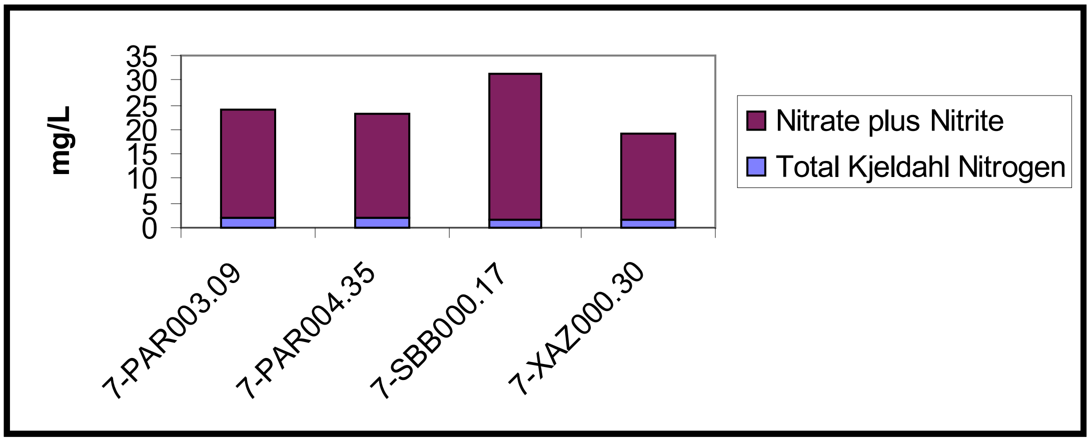
Figure 16 contrasts the average nitrogen concentrations for the Eastern Shore Bayside, Eastern Shore Seaside and Western Shore Bay stations. Excluding Sandy Bottom Bridge Creek (bayside) and Parkers Creek (seaside), average total nitrogen concentrations of the Eastern Shore bayside and seaside sites were two - three times higher than concentrations in Western Shore Bay with inorganic nitrogen (Nitrate plus Nitrite) accounting for approximately 40% of the total nitrogen in the Eastern shore bayside sites, 71% of the total nitrogen at the Eastern Shore seaside sites and only 6% of the total nitrogen in the Western shore sites. The Virginia Long Term Ecological Program found inorganic nutrient concentrations were significantly higher in the barrier-island lagoon than those in Chesapeake Bay (Shugart, H.H. and L.K. Blum, Annual Progress Report VCR/LTER. May 1991. Department of Environmental Sciences Clark Hall University of Virginia Charlottesville, Virginia 22903). Bacterial abundance, activity, and growth rates were also found to be much lower in the barrier-island lagoon system indicating nutrient cycles and controls on the cycles may be very different in the lagoon system as compared to Chesapeake Bay. A likely source of inorganic nitrogen is runoff and groundwater contamination from agricultural activities since the Eastern Shore is largely comprised of agricultural and forested lands. Inorganic nitrogen concentrations were unusually high in Sandy Bottom Bridge Creek and Parkers Creek, accounting for 92-94% of average total nitrogen concentrations. Total nitrogen concentrations in those creeks during 2002 were 18 - 25 times higher than the average concentrations for the remaining stations as combined in bayside and seaside creek groups (Figure 16b).

Figure 16) 2002 Total Nitrogen Concentrations.

a. Average concentrations for 2002 indicate highest concentrations occur in seaside creeks and embayments.



b. 2002 Total Nitrogen concentrations for Sandy Bottom Bridge Creek (7-SBB000.17 and 7-XAZ000.30) and Parkers Creek (7-P AR003.09 and 7-PAR004.35).

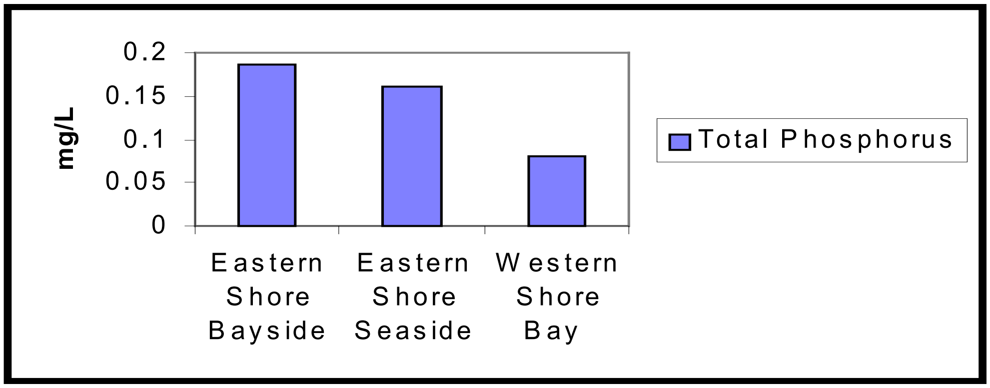


As with total nitrogen, phosphorus concentrations in Eastern Shore bayside tributaries and Eastern Shore seaside tributaries are greater than those found in the Western Shore Bay and are probably a result of agricultural activities (Figure 17a). In 1996 Agricultural crops were reported to contribute 65% of the phosphorus loads on the Eastern shore with a 33% increase having occurred between 1985 and 1996 due to increased poultry operations within the watershed.

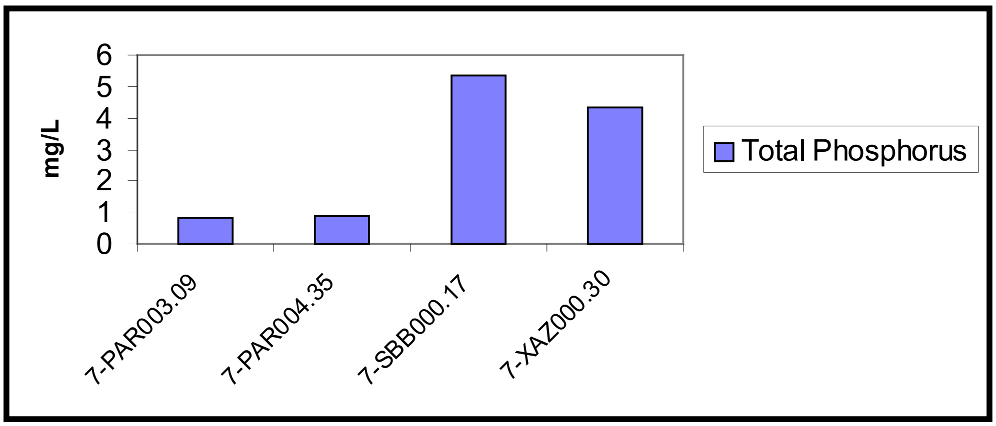
As with nitrogen concentrations, Sandy Bottom Branch Creek, an un-named tributary to Sandy Bottom Branch Creek and two stations on Parkers Creek had unusually high levels of total phosphorus (Figure 17b). These creeks have been listed on the 305B report as impaired for exceeding the nutrient screening value for total phosphorus.

Figure 17) 2002 Total Phosphorus Concentrations.

a. Total Phosphorus concentrations in Eastern Shore Bayside tributaries, Eastern Shore Seaside tributaries and Western Bay Creeks excluding Sandy Bottom Branch and Parkers Creek.

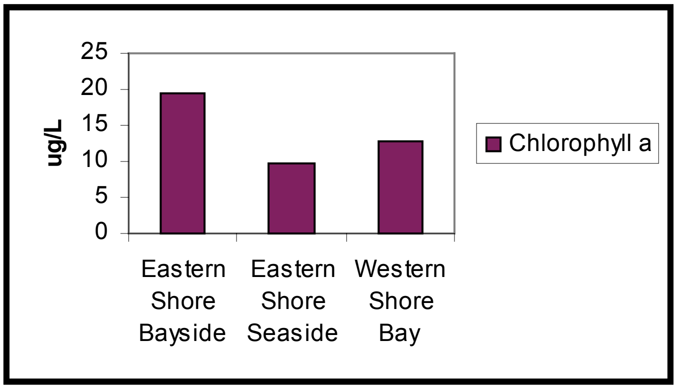


b. Total Phosphorus concentrations in Sandy Bottom Branch (7-SBB000.17, 7-XAZ000.30) and Parkers Creek (7-PAR003.09 and 7-PAR004.35).



Chlorophyll concentrations for the Eastern Shore Bayside tributaries, Eastern Shore Seaside tributaries and Western Shore Bay are depicted in Figure 18. Chlorophyll a concentrations were highest in the Bayside tributaries and lowest in the Seaside tributaries. Both the Eastern Shore Bayside and the Western Shore Bay sites have less suspended solid concentrations than in the Eastern Shore seaside and thus better water clarity which may allow for better phytoplankton growth. Higher concentrations probably occur in the Eastern Shore Bayside due to the high concentrations of inorganic nutrients readily available for phytoplankton uptake. Studies conducted by the Virginia Coastal Reserve Long Term Ecological Research (LTER) have suggested primary productivity in the barrier-island lagoon system is light limited due to water-column sediment loading rather than nutrient limited (Shugart, H.H. and L.K. Blum, Annual Progress Report VCR/LTER. May 1991. Department of Environmental Sciences Clark Hall University of Virginia Charlottesville, Virginia 22903).

Figure 18) 2002 Chlorophyll a concentrations.



Appendix A: Nutrient Discharge Estimates for Virginia's Significant Point Source Facilities

Table A-1: POTOMAC RIVER BASIN
2002 POINT SOURCE NITROGEN DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TN LOAD DISCH. (LBS/YR)	1985 TN LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Waynesboro	DuPont-Waynesboro	48,950	299,630	-84%
Frederick	FWSA-Opequon STP	66,430	226,560	-71%
Prince William	Quantico-Mainside STP	28,400	82,540	-66%
Rockingham	Merck-Elkton	83,510	233,880	-64%
Prince William	PWCSA-Mooney STP	229,530	609,160	-62%
Staunton	Staunton-Middle River STP	74,990	162,810	-54%
Arlington	Arlington STP	890,730	1,641,280	-46%
Rockingham	SIL Clean Water STP	43,500	72,420	-40%
Rockingham	HRRSA-North River STP	223,060	367,160	-39%
King George	King George-Dahlgren STP	3,880	5,690	-32%
Waynesboro	Waynesboro STP	134,730	190,930	-29%
Loudoun	Leesburg STP	56,280	71,730	-22%
Warren	Front Royal STP	92,260	112,140	-18%
Rockingham	Pilgrims Pride-Hinton	35,470	42,970	-17%
Shenandoah	Woodstock STP	24,440	26,760	-9%
Fairfax	Noman Cole STP	2,041,160	2,225,840	-8%
DC	Blue Plains - VA Portion	777,370	814,170	-5%
Augusta	ACSA-Fishersville STP	43,440	44,400	-2%
Stafford	Aquia STP	64,370	64,890	-1%
Augusta	ACSA-Stuarts Draft STP	30,120	28,460	6%
Shenandoah	Strasburg STP	48,720	42,120	16%
Prince William	Dale Serv. Corp. #1	110,880	91,320	21%
Augusta	Weyers Cave STP	38,380	28,720	34%
Alexandria	Alexandria STP	2,687,530	1,994,010	35%
Westmoreland	Colonial Beach STP	33,030	22,770	45%
Shenandoah	New Market STP	22,530	15,140	49%
Loudoun	Purcellville STP	22,880	15,370	49%
Shenandoah	Stoney Creek San. Dist. STP	22,150	14,690	51%
Prince William	Dale Serv. Corp. #8	74,950	38,360	95%
Loudoun	Round Hill STP	6,820	3,420	99%
Fairfax	Upper Occoquan S.A.	1,378,400	597,530	131%
Shenandoah	George's Chicken LLC	375,860	147,310	155%
Page	Luray STP	16,060	3,380	375%
Rockingham	Massanutten PSA STP	17,240	NA	NA
Frederick	Parkins Mill STP	83,590	NA	NA
King George	USNSWC-Dahlgren STP	5,500	NA	NA
	Totals =	**9,937,140**	**10,868,740**	**-9%**

Table A-2: POTOMAC RIVER BASIN
2002 POINT SOURCE PHOSPHORUS DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TP LOAD DISCH. (LBS/YR)	1985 TP LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Waynesboro	DuPont-Waynesboro	1,150	57,200	-98%
Frederick	FWSA-Opequon STP	3,800	77,540	-95%
Arlington	Arlington STP	5,010	46,890	-89%
King George	King George-Dahlgren STP	270	1,950	-86%
Rockingham	HRRSA-North River STP	24,480	125,660	-81%
Warren	Front Royal STP	8,140	38,380	-79%
Staunton	Staunton-Middle River STP	13,930	55,720	-75%
Fairfax	Noman Cole STP	10,690	30,090	-64%
Shenandoah	Woodstock STP	3,270	9,160	-64%
Loudoun	Leesburg STP	9,870	25,320	-61%
Augusta	Weyers Cave STP	1,200	3,020	-60%
Prince William	Quantico-Mainside STP	360	880	-59%
Shenandoah	Strasburg STP	6,510	14,420	-55%
Waynesboro	Waynesboro STP	23,380	48,320	-52%
Alexandria	Alexandria STP	8,260	16,260	-49%
Loudoun	Purcellville STP	3,060	5,260	-42%
Shenandoah	Stoney Creek San. Dist. STP	2,960	5,030	-41%
Stafford	Aquia STP	1,260	2,050	-39%
Prince William	Dale Serv. Corp. #1	690	1,100	-37%
Prince William	PWCSA-Mooney STP	2,470	3,690	-33%
Shenandoah	New Market STP	4,020	5,180	-22%
Loudoun	Round Hill STP	910	1,170	-22%
Augusta	ACSA-Fishersville STP	12,840	15,200	-16%
Prince William	Dale Serv. Corp. #8	740	840	-12%
Augusta	ACSA-Stuarts Draft STP	8,630	9,740	-11%
Westmoreland	Colonial Beach STP	7,260	7,790	-7%
DC	Blue Plains - VA Portion	9,660	6,850	41%
Rockingham	Merck-Elkton	113,270	60,580	87%
Rockingham	Pilgrims Pride-Hinton	56,060	26,320	113%
Page	Luray STP	8,250	2,930	182%
Rockingham	SIL Clean Water STP	65,240	21,450	204%
Fairfax	Upper Occoquan S.A.	2,690	860	213%
Shenandoah	George's Chicken LLC	98,780	19,090	417%
Rockingham	Massanutten PSA STP	4,070	NA	NA
Frederick	Parkins Mill STP	11,180	NA	NA
King George	USNSWC-Dahlgren STP	4,280	NA	NA
	Totals =	**538,640**	**762,680**	**-29%**

Table A-3: RAPPAHANNOCK RIVER BASIN
2002 POINT SOURCE NITROGEN DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TN LOAD DISCH. (LBS/YR)	1985 TN LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Fredericksburg	Fredericksburg STP	56,070	146,300	-62%
Fauquier	Remington STP	5,420	10,250	-47%
Essex	Tappahannock STP	7,920	12,520	-37%
Lancaster	Kilmarnock STP	7,570	9,680	-22%
Fauquier	Warrenton STP	55,060	59,770	-8%
Orange	Orange STP	32,180	34,720	-7%
Middlesex	Urbanna STP	3,110	2,850	9%
Stafford	Little Falls Run STP	55,900	50,090	12%
Culpeper	Culpeper STP	61,160	52,560	16%
Northumberland	Reedville STP	2,030	1,710	19%
Northumberland	Omega Protein	78,410	50,130	56%
Spotsylvania	Massaponax STP	155,010	88,230	76%
Richmond	Warsaw STP	9,120	4,550	100%
Caroline	Ft. A.P. Hill - Wilcox STP	8,310	2,960	181%
Richmond	Haynesville CC STP	3,640	850	328%
Orange	Wilderness STP	29,030	NA	NA
Spotsylvania	FMC STP	35,820	NA	NA
Westmoreland	Montross STP	790	NA	NA
	Totals =	**606,550**	**552,910**	**10%**

Table A-4: RAPPAHANNOCK RIVER BASIN
2002 POINT SOURCE PHOSPHORUS DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TP LOAD DISCH. (LBS/YR)	1985 TP LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Fredericksburg	Fredericksburg STP	6,700	50,070	-87%
Spotsylvania	Massaponax STP	6,630	29,580	-78%
Essex	Tappahannock STP	1,020	4,290	-76%
Fauquier	Warrenton STP	6,520	20,460	-68%
Orange	Orange STP	4,300	11,880	-64%
Culpeper	Culpeper STP	12,090	32,450	-63%
Northumberland	Reedville STP	270	580	-53%
Lancaster	Kilmarnock STP	1,560	3,310	-53%
Stafford	Little Falls Run STP	10,210	17,140	-40%
Middlesex	Urbanna STP	720	970	-26%
Richmond	Warsaw STP	1,220	1,560	-22%
Fauquier	Remington STP	2,920	3,510	-17%
Caroline	Ft. A.P. Hill - Wilcox STP	1,080	1,010	7%
Northumberland	Omega Protein	3,060	2,230	37%
Richmond	Haynesville CC STP	610	290	110%
Orange	Wilderness STP	3,880	NA	NA
Spotsylvania	FMC STP	1,640	NA	NA
Westmoreland	Montross STP	150	NA	NA
	Totals =	**64,580**	**191,610**	**-66%**

Table A-5: YORK RIVER BASIN
2002 POINT SOURCE NITROGEN DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TN LOAD DISCH. (LBS/YR)	1985 TN LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Orange	Gordonsville STP	4,620	31,310	-85%
King William	Smurfitt-Stone	196,830	586,340	-66%
Hanover	Ashland STP	19,030	35,050	-46%
King William	West Point STP	22,300	28,460	-22%
Mathews	Mathews Courthouse STP	2,100	1,710	23%
York	HRSD-York STP	595,650	481,920	24%
Hanover	Doswell STP	83,370	65,550	27%
Caroline	Caroline Co. STP	17,020	NA	NA
New Kent	Parham Landing STP	1,450	NA	NA
York	Giant -Yorktown Refinery	261,410	157,760	NA
	Totals =	**1,203,780**	**1,388,100**	**-13%**

Table A-6: YORK RIVER BASIN
2002 POINT SOURCE PHOSPHORUS DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TP LOAD DISCH. (LBS/YR)	1985 TP LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Orange	Gordonsville STP	470	10,720	-96%
King William	Smurfitt-Stone	44,230	241,530	-82%
York	HRSD-York STP	47,750	152,130	-69%
Mathews	Mathews Courthouse STP	200	580	-66%
King William	West Point STP	4,170	9,740	-57%
Hanover	Ashland STP	6,140	12,300	-50%
Hanover	Doswell STP	46,280	19,730	135%
Caroline	Caroline Co. STP	1,440	NA	NA
New Kent	Parham Landing STP	360	NA	NA
York	Giant -Yorktown Refinery	13,980	2,220	NA
	Totals =	**165,020**	**448,950**	**-63%**

Table A-7: JAMES RIVER BASIN
2002 POINT SOURCE NITROGEN DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TN LOAD DISCH. (LBS/YR)	1985 TN LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Prince Edward	Farmville STP	1,490	27,110	-95%
Campbell	BWX-Tech NNFD	176,480	728,250	-76%
Hanover	Tyson Foods-Glen Allen	32,580	132,470	-75%
Rockbridge	Lex-Rockbridge Reg. STP	13,080	49,520	-74%
Hopewell	Hopewell STP	1,819,680	6,101,060	-70%
Hopewell	Honeywell Co.-Hopewell	1,347,480	4,460,620	-70%
Nottaway	Crewe STP	4,280	11,400	-62%
Chesterfield	Falling Creek STP	245,700	637,370	-61%
Lynchburg	Lynchburg STP	194,840	460,840	-58%
Norfolk	HRSD-VIP STP	806,830	1,866,760	-57%
Buena Vista	Buena Vista STP	49,240	107,020	-54%
Chesterfield	Brown & Williamson	27,540	49,350	-44%
Petersburg	So. Central W.W.A. STP	303,550	513,180	-41%
James City	HRSD-Williamsburg STP	457,730	632,010	-28%
Chesterfield	Phillip Morris	138,190	152,500	-9%
Chesterfield	DuPont-Spruance	168,520	183,890	-8%
Newport News	HRSD-Boat Harbor STP	1,003,930	1,077,400	-7%
Alleghany	Covington STP	103,460	109,300	-5%
Suffolk	HRSD-Nansemond STP	879,160	896,890	-2%
Clifton Forge	Clifton Forge STP	64,500	64,890	-1%
Chesterfield	Proctors Creek STP	263,390	258,100	2%
Norfolk	HRSD-Army Base STP	866,000	773,450	12%
Alleghany	MeadWestvaco	717,530	554,760	29%
Newport News	HRSD-James River STP	938,350	725,030	29%
Virginia Beach	HRSD-Ches/Eliz STP	1,339,870	995,790	35%
Albemarle	RWSA-Moores Creek STP	448,620	288,990	55%
Rockbridge	Lees Commercial Carpet	37,890	24,380	55%
Fluvanna	Lake Monticello STP	31,210	13,840	126%
Bedford	Georgia-Pacific	260,350	54,960	374%
Henrico	Henrico STP	1,901,090	NA	NA
Richmond	Richmond STP	1,647,520	2,462,870	NA
	Totals =	**16,290,080**	**24,414,000**	**-33%**

Table A-8: JAMES RIVER BASIN
2002 POINT SOURCE PHOSPHORUS DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TP LOAD DISCH. (LBS/YR)	1985 TP LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Nottaway	Crewe STP	180	3,900	-95%
Chesterfield	Phillip Morris	9,540	60,580	-84%
Buena Vista	Buena Vista STP	6,580	36,630	-82%
Suffolk	HRSD-Nansemond STP	68,040	349,080	-81%
Alleghany	Covington STP	7,470	37,410	-80%
Chesterfield	Falling Creek STP	33,230	140,340	-76%
Hopewell	Hopewell STP	41,800	175,440	-76%
Petersburg	So. Central W.W.A. STP	34,460	144,560	-76%
Newport News	HRSD-James River STP	63,500	258,780	-75%
Chesterfield	Brown & Williamson	3,540	13,600	-74%
Newport News	HRSD-Boat Harbor STP	70,040	260,550	-73%
Norfolk	HRSD-Army Base STP	49,340	177,940	-72%
Chesterfield	DuPont-Spruance	7,360	22,200	-67%
Norfolk	HRSD-VIP STP	128,110	381,990	-66%
Virginia Beach	HRSD-Ches/Eliz STP	98,820	284,140	-65%
Rockbridge	Lex-Rockbridge Reg. STP	6,570	16,950	-61%
James City	HRSD-Williamsburg STP	50,850	112,440	-55%
Lynchburg	Lynchburg STP	109,910	196,310	-44%
Clifton Forge	Clifton Forge STP	14,490	22,210	-35%
Rockbridge	Lees Commercial Carpet	32,240	37,870	-15%
Fluvanna	Lake Monticello STP	4,170	4,740	-12%
Chesterfield	Proctors Creek STP	52,870	55,550	-5%
Prince Edward	Farmville STP	9,520	9,280	3%
Albemarle	RWSA-Moores Creek STP	98,750	90,860	9%
Hopewell	Honeywell Co.-Hopewell	57,830	29,320	97%
Campbell	BWX-Tech NNFD	1,740	410	324%
Bedford	Georgia-Pacific	148,200	32,120	361%
Hanover	Tyson Foods-Glen Allen	680	140	386%
Alleghany	MeadWestvaco	224,270	20,110	1015%
Henrico	Henrico STP	181,110	NA	NA
Richmond	Richmond STP	81,890	839,070	NA
	Totals =	**1,697,100**	**3,814,520**	**-56%**

Table A-9: EASTERN SHORE BASIN
2002 POINT SOURCE NITROGEN DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TN LOAD DISCH. (LBS/YR)	1985 TN LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Accomack	Tyson-Temperanceville	144,970	277,400	-48%
Accomack	Tangier STP	3,660	3,420	7%
Accomack	Onancock STP	10,060	6,260	61%
Northampton	Cape Charles STP	5,570	NA	NA
	Totals =	**164,260**	**287,080**	**-43%**

Table A-10: EASTERN SHORE BASIN
2002 POINT SOURCE PHOSPHORUS DISCHARGE INVENTORY

LOCATION	FACILITY	2002 TP LOAD DISCH. (LBS/YR)	1985 TP LOAD DISCH. (LBS/YR)	% CHANGE FROM 1985
Accomack	Tangier STP	490	1,170	-58%
Accomack	Onancock STP	1,350	2,140	-37%
Accomack	Tyson-Temperanceville	27,910	36,530	-24%
Northampton	Cape Charles STP	750	NA	NA
	Totals =	**30,500**	**39,840**	**-23%**